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RAINFALL TYPES OF THE UNITED STATES

By ROBERT DeC. WARD

Harvard University

IMPORTANCE OF RAINFALL TYPES

“When does the rain come?” is a question the correct answer to which often concerns the farmer and the engineer more than does the answer to the question “How much rain falls in a year?” A relatively small amount of precipitation may be so distributed that most of it comes just when the crops have the greatest need of it. In our own country, great progress has been made in agriculture, especially in the semi-arid regions, through the selection of crops whose periods of growth and of maturity coincide with the season of most abundant rainfall. In earlier years, failure often resulted from an attempt to raise crops which were not adapted to the rainfall type of their particular district. Soil conditions depend to no small degree on the season at which most of the rain falls. There must inevitably be a considerable difference in the processes of weathering between two places, one of which has dry summers and the other of which has rainy summers. The rainfall type is thus both directly and indirectly important in agriculture: directly, as furnishing the rainfall for the immediate use of the plants, and, indirectly, through the relation of the rainfall season to the processes of weathering and of soil formation. The water available for mills, for electric-power plants, for irrigation, for water supply also depends upon the rainfall type. The latter determines the size of the reservoirs, the length of the period needed for the storage of the water, the loss by evaporation, in short, the general availability of the water supply. The desirability of a region as a health or as a pleasure resort depends largely upon the season at which the most or the least rain falls.

OUR RAINFALL TYPES AND THE METHOD OF ILLUSTRATING THEM

The rainfall types here adopted are based upon an examination of a large number of plotted monthly rainfall amounts for selected stations in all parts of the United States and upon a revision, on the basis of these curves, of the rainfall types suggested by General A. W. Greely¹ and by Professor A. J. Henry.² Greely's rainfall types are very simple. There are but six in all. Each has characteristically a single maximum and a single minimum. Each pertains essentially to a single body of water. Composite

¹ A. W. Greely: Rainfall Types of the United States, *Natl. Geogr. Mag.*, Vol. 5, 1893, pp. 45-58, Pl. 20.

² A. J. Henry: Rainfall of the United States, With Annual, Seasonal, and Other Charts, *Weather Bur. Bull. D*, U. S. Dept. of Agric., Washington, 1897, 58 pp. [Pp. 11-13 and Pl. 1 concern rainfall types.]

Idem: Climatology of the United States, *Weather Bur. Bull. Q*, U. S. Dept. of Agric., Washington, 1906, 1012 pp. [Pp. 50-51 and Pl. 27 concern rainfall types.]

types are purposely omitted. Henry's classification embraces ten types. Several of these are closely identical with those of Greely. They have been illustrated by means of a series of diagrams showing the monthly rainfall amounts in percentages of the annual means. They include complex (double maxima and minima) as well as simple types. Other suggestions regarding rainfall types are referred to in the general bibliography at the end of this paper.

Each type or sub-type of the present writer's classification is illustrated by a curve showing the monthly amounts of rainfall. These curves are composites. Each one is based upon the records from several (usually five or six) stations, in the same general district. There is a distinct advantage in using a composite instead of the curve for a single station. When the data for several stations are combined, individual local peculiarities and errors, arising from the topography, the altitude, the exposure of the gauge, and from other local controls, are to a considerable degree neutralized. For the purposes of a general comparative study, the composite curve is thus more useful than the curve for a single station. Two things should be borne in mind when considering rainfall types. First, it must not, of course, be expected that the curve for any individual station will necessarily agree absolutely with the type curve for the district, which is a composite. These composite curves show the dominant type of rainfall distribution over the areas for which they have been selected as illustrations. Many individual stations over these same areas naturally depart more or less from the type, especially towards the margins of the areas. Second, the distribution of rainfall at a station in any given year often differs considerably from the general type, which is based upon the records of many years.

Each of the accompanying curves is plotted on the same scale. The height of the diagram therefore gives, at a glance, an indication of the amounts of rainfall. The approximate annual rainfalls over the district for which the curves are representative are noted in each case. Although the type, and not the amount, is here under discussion, some general idea of the monthly amounts of precipitation is inevitably gained by even a hasty glance at the curves, and it will be useful, in our further study of rainfall, if we incidentally learn something about the annual amounts. The general location of each type is indicated on the accompanying map (Fig. 1). The solid black lines indicate the climatic subdivisions or provinces of the United States which have been suggested by the present writer.³ These provinces form a convenient and rational basis for a discussion of the climatology of the United States. Although suggested and adopted for other reasons, these subdivisions are on the whole well adapted for use in our present investigation. Except in the few cases where well-

³ R. DeC. Ward: *The Climatic Subdivisions of the United States*, *Bull. Amer. Geogr. Soc.*, Vol. 47, 1915, pp. 672-680. [Abstract in *Monthly Weather Rev.*, Vol. 43, 1915, pp. 467-468.]

defined mountain barriers intervene, as in the case of part of the Sierra Nevada-Cascade and Rocky Mountain divides, one rainfall type naturally merges gradually into the neighboring one. There are, therefore, few sharp division lines. The boundaries shown on our map are not to be taken as indicating sudden transitions.

RAINFALL TYPES OF THE EASTERN CLIMATIC PROVINCE

The outstanding fact regarding the seasonal rainfall over most of the great area which lies east of the Rocky Mountains is the predominance of summer rains. Such a distribution is entirely in accord with the general

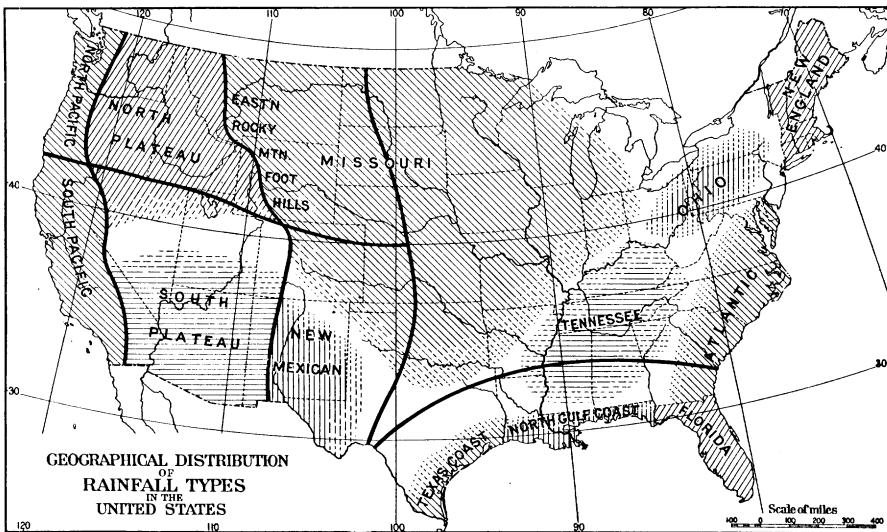


FIG. 1.—Outline map, 1:42,000,000, showing, in ruling, the distribution of the rainfall types and, by heavy black lines, the climatic provinces of the United States. The latter, which are left nameless above, are taken from a map on p. 678 in the article by the author cited in footnote 3, above. Proceeding from east to west the names of the climatic provinces are: Eastern Gulf, Northern Plains, Southern Plains, Northern Plateau, Southern Plateau, Northern Pacific, Southern Pacific.

continental character of the climate of this area as a whole. Warm-season rains are typically the rains of continental interiors. They occur when the continental indraft of the warmer months brings in warm, damp air from the surrounding water areas and when high temperatures favor local showers.

The most characteristic rainfall type of our Eastern Province, both because it covers the largest area and because its curve so emphatically indicates continental control, is that which, following Greely, is named *Missouri*. This type prevails over most of our Plains Province, extends eastward well over the prairie states and into the Great Lakes region, and is found as far south as northern Texas. Figure 2 is a composite curve illustrating the Missouri type. The winter precipitation is very light.

Most of the year's supply of rainfall comes in late spring and early summer. The maximum is usually in June. Similar conditions are found over the Russian steppes, as pointed out by Woeikof. This type of rainfall brings the maximum at the season when rainfall is most needed by the crops. While such a distribution may be of relatively little importance in a region where the total annual precipitation is more than enough for agricultural uses, it is obviously of great moment where the year's rainfall at best scarcely suffices for the demands of our staple crops. Fall-sown grain over most of the Eastern United States grows little or not at all in winter. It makes a rapid start in spring, and therefore the months from April to August are the most critical for our Eastern staple crops.

While the area embraced by the Missouri type is very extended, the general character of the curve is maintained with extraordinary persistency. Towards the margins of the district, to the east, south, and west, certain modifications are noted. A number of stations around the Upper Lakes, e. g. in eastern Minnesota, eastern Wisconsin, the upper peninsula of Michigan, etc., have the Missouri primary maximum in June and a secondary maximum in September. In going east, also, as the vicinity of the Lower Lakes and of the Ohio Valley is reached, the precipitation of the winter months becomes distinctly more marked. We may, therefore, set apart the *Ohio* type, whose general location is indicated on our map (Fig. 1) and whose curve is illustrated in Figure 3. The continental summer maximum of the Missouri type, here somewhat retarded into July, is still clearly shown, but the increase in winter rainfall and the resulting smaller annual range are marked. The location of this Ohio area in a part of the country where cyclonic rainfalls are both frequent and abundant, and where the winter and spring cyclones from the Southwest and from the Gulf of Mexico are particularly heavy rain-bringers, sufficiently explains the wet winters of the Ohio type. The winter precipitation of the Ohio type is heavier than that in the Great Lakes region generally and is more often rain, while over the Great Lakes themselves, especially the Upper Lakes, more snow falls.

Still farther east the distribution of rainfall through the year becomes more and more uniform, especially as we approach that interesting north-eastern section of our country which, sooner or later, comes within the rain



FIG. 2—Missouri type. Mean annual rainfall, 20-30 inches.

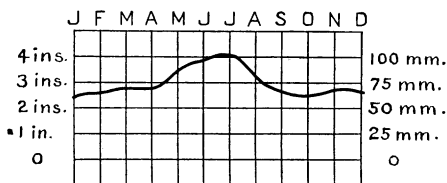


FIG. 3—Ohio type. Mean annual rainfall, 35-40 inches.

area of most of the storms which pass over the United States. In the type which we may call *New England* we have the most uniform distribution of precipitation which prevails anywhere in our whole country (Fig. 4). The variation from month to month is too slight to be of any economic

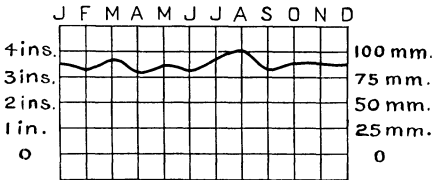


FIG. 4.—New England type. Mean annual rainfall, 40-45 inches.

importance. Droughts are about as likely to occur in one season as in another, but are, of course, more critical in summer. Throughout the year there is usually enough water to keep the rivers well supplied and available for power. We can hardly speak of any maxima and minima, although August, in the long run, is somewhat the rainiest month. This, as will be seen in a moment, is a marked characteristic of our seaboard district along the southern Atlantic coast. The New England curve is obviously affected by controls which dominate the rainfall types of adjacent regions. Some of the stations show a tendency to a slight November maximum, which is a characteristic of the St. Lawrence Valley (Greely). This uniform distribution of rainfall is seen, more or less clearly, over the area directly west and southwest of New England. New York City, Philadelphia, Washington, all have rainfall curves which do not differ greatly from the composite shown in Figure 4, or from the curve of Boston. With increasing distance from the coast, the tendency toward a mid-summer (July) maximum becomes more marked.

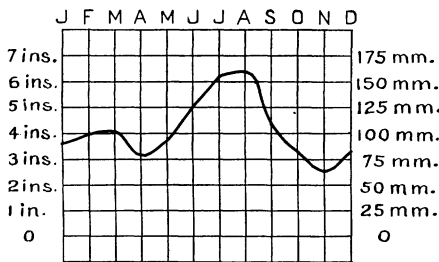


FIG. 5.—Atlantic type. Mean annual rainfall, 45-50+ inches.

Farther south, over the Atlantic Coast states lying between Virginia and Florida, there is a well-defined late summer maximum, usually in August; a minimum in middle or late autumn (October or November); a secondary maximum in late winter (March); and a secondary minimum in spring (April). Von Hann has selected the Atlantic coast of North America in latitude 40°N. as being a

typical example of extra-tropical coast rains with a dry spring. The remarkably uniform distribution of rainfall throughout the year is peculiar to this particular district. The percentages of rainfall by seasons are as follows:

<i>Dec.-Feb.</i>	<i>March-May</i>	<i>June-Aug.</i>	<i>Sept.-Nov.</i>
24	23	27	26

This type, which is best termed the *Atlantic*, gradually merges on the north into the very uniform rainfall distribution just considered, which attains its most characteristic development in New England. On the south,

the Atlantic type merges into that of Florida. Figure 5, based on records from stations in North and South Carolina and Georgia, illustrates the Atlantic type. The late summer maximum, which is best marked on the coast, is controlled by the frequent and heavy thundershowers of the warmest months, together with the additional precipitation which comes in connection with occasional West Indian hurricanes. The winter rains result from the general cyclonic storms of that season. The Atlantic type, with its abundant supply of rainfall throughout the year, is obviously well adapted to furnish water-power at all seasons, while its warm-season maximum is favorable for crops.

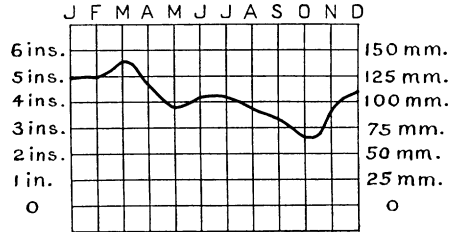


FIG. 6—Tennessee type. Mean annual rainfall, 45-55 inches.

Over the whole great region east of the Rocky Mountain divide there is but one rainfall type which has a single maximum in winter. This prevails over Tennessee and parts of the adjoining states, especially those immediately to the north and south, and was therefore named the *Tennessee* type by Greely. Because of its prevalence over the southern portions of the Appalachian Mountains, Henry has called it Southern Appalachian and Tennessee. The curve given in Figure 6 illustrates this type. There is a single maximum in late winter or early spring (March), and a well-marked minimum in mid-autumn (October), when the general storm control is relatively inactive. Droughts are not infrequent in the autumn, with damage to crops. Towards the margins of the Tennessee area, both on the east and south, the tendency to a second maximum in middle or late summer is very noticeable. The warm and damp southerly winds of the cyclonic storms of late winter and spring

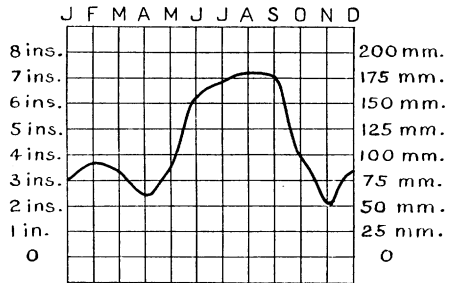


FIG. 7—Florida type. Mean annual rainfall, 50-55 inches.

which cross this area on their way north from Texas or the Gulf are responsible for the heavy rainfall of the Tennessee maximum, just as they bring the winter rains of the Ohio type, previously noted. These late winter and early spring rains not infrequently cause floods in the rivers of this region. Topography is an important factor in causing locally excessive precipitation.

RAINFALL TYPES OF THE GULF PROVINCE

The Gulf climatic province is overlapped, on the north and northeast, by the Tennessee and the Atlantic types. Its own rainfall distribution is

rather complex and cannot be generalized into a single type. As a whole, the rainiest season is late summer or early autumn. These conditions are satisfactorily explained by the fact that the warm and moist prevailing summer winds over this area come directly from the Atlantic Ocean

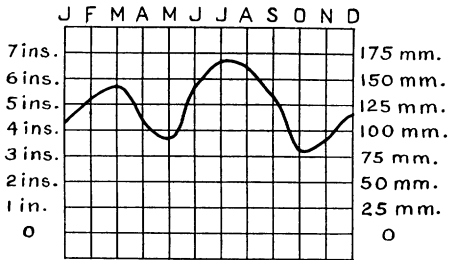


FIG. 8—North Gulf Coast type. Mean annual rainfall, 55-60+ inches.

and from the Gulf of Mexico, that thunderstorms are of frequent occurrence, and that local cyclonic depressions and West Indian hurricanes contribute their share of precipitation. Although our Gulf Province is a small one, three distinct rainfall types may be distinguished. The type which may well be called the *Florida* type is distinctly tropical in character (Fig. 7). June to September constitute a true rainy season. August and September are generally the rainiest months. These are local convectional rainfalls. Florida is also much exposed to tropical hurricanes, which all too often bring their characteristic destructive gales and flooding downpours. A faint secondary maximum is noted in winter. Because of the dry autumn and spring in northern Florida much interest has there been taken in sub-surface and surface irrigation. Along the northern Gulf coast there is a complex type which we have called the *North Gulf Coast* type, with a late winter and early spring secondary maximum, similar to the primary

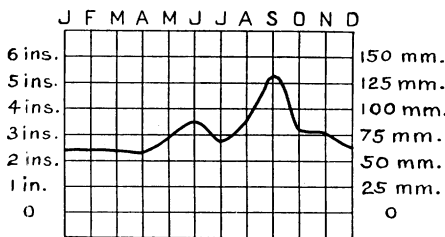


FIG. 9—Texas Coast type. Mean annual rainfall, 25-45+ inches.

This we have designated the *Texas Coast* type. The curve is so different from the two other curves of the Gulf Province that it deserves a special name, although it occupies but a limited area on the coast of Texas. Farther inland, Texas stations show more and more tendency towards an earlier maximum, like that of the Missouri type, and there is an intermediate belt of country in which a transition type is found, with the September maximum of the coast and the early summer maximum of the interior.⁴

⁴ A. W. Greely: Some Peculiarities in the Rainfall of Texas, *Bull. Philos. Soc. of Washington*, Vol. 12, 1892, p. 53.

RAINFALL TYPES OF THE PLAINS PROVINCE

The dominant rainfall type over the Northern Plains is that already described as the Missouri (Fig. 2). The economic importance of this type of rainfall is much greater over the Plains, where the annual rainfall is either insufficient or barely sufficient for agriculture, than it is farther east, where the annual precipitation is heavier and the season at which the rain comes makes less difference. It may without exaggeration be said that, if a man were allowed 20 inches, or less, of precipitation a year and were told to distribute this amount throughout the year so that

it might be of the greatest benefit to the crops over an area like that of our northern and central Great Plains, he could not devise any type of distribution more favorable than that of our Missouri type. The moisture which supplies these beneficent rains comes chiefly from the Gulf of Mexico, but probably also to some extent from the waters of the Great Lakes. The spring and early summer maximum is essentially due to thundershowers, both those which are simply local convectional overturnings of heated air (heat thunderstorms) and those which occur in connection with the relatively weak cyclonic depressions of the hotter months. These summer rains are important in supplementing the water supply which is obtained by the use of the rivers. As pointed out by Greely,⁵ "it is well known that the annual rainfall is small, yet eastern Nebraska receives, during these four months, April to July inclusive, a larger amount of rainfall than the interior portions of the eastern states from Maine to Virginia; and western Nebraska receives only a slightly lesser amount." These rains of spring and early summer are either of direct benefit, in falling upon the growing crops, or of indirect benefit, in coming at a time when they are of most use for irrigation. It is readily seen that there is a distinct

advantage in having the rainfall maximum over before the harvesting season. Hay and grain may thus be left outdoors with little danger of injury by rains. The relatively dry autumns are favorable to the occurrence and spreading of "prairie fires," about which much used to be heard. The very moderate winter precipitation, which is mostly snow except in the southern sections, has the advantage of being generally so light and dry that the cattle ranges are not rendered inaccessible. It is, furthermore, an excellent protection for the forage grasses and keeps the soil from freezing



FIG. 10—Eastern Rocky Mountain Foothills type. Mean annual rainfall, 10-15 inches.

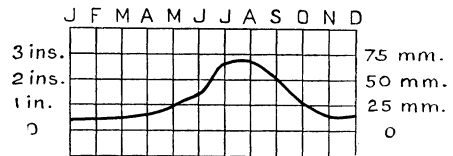


FIG. 11—New Mexican type. Mean annual rainfall, 10-15 inches.

⁵ *Op. cit.* in footnote 1.

deeply. In the foothills, the winter winds blow this light snow into the gullies and hollows, leaving much of the open country bare for grazing.

The Missouri type extends well into the climatic province of the Southern Plains, but, as is to be expected, the simple type illustrated in Figure 2 gradually loses its distinguishing character and becomes more complex. Thus, in eastern Colorado, in western Texas, and in Oklahoma, for example, we find many transitional types which show the ear-marks of adjacent rainfall types of different character and often have two maxima. Along the eastern base of the Rocky Mountains, chiefly in the Northern Plains Province but also extending across into the Southern Plains Province, the maximum comes in May (or even April) rather than in June. This may be considered a slight modification of the pure Missouri type and may be called the *Eastern Rocky Mountain Foothills* type (Henry). The curve is shown in Figure 10, and its general location is indicated on the map (Fig. 1).

In the southwestern corner of the Plains Province, in New Mexico, and in extreme western ("Trans-Pecos") Texas, there is a simple rainfall type, illustrated in Figure 11, with a dry winter and a well-marked mid- or late summer rainfall maximum (July-August). This somewhat resembles the Missouri type, but has drier winters and a later maximum. The winters of this type, which we call the *New Mexican*, are dry because the district is well removed from sources of moisture and because it is visited by but few cyclones, of which not many bring precipitation of consequence. The summer rains come in local thunderstorms, which occur with great regularity, frequency, and intensity over the heated mountains and plateaus of this semi-arid area. Most of this summer precipitation is available for crops only indirectly, through irrigation. The rainfall of this type comes mostly in showers of comparatively short duration. Outdoor occupations are thus seldom long interrupted by wet weather.

RAINFALL TYPES OF THE PLATEAU PROVINCE

The rainfall types of the great inter-mountain Plateau Province are interesting because of their transitional character. As a whole, the dominant characteristic of the rainfall distribution west of the Rocky Mountains is the cold-season maximum (except over the southern portion of the Southern Plateau Province). This is especially marked on the Pacific Slope. The summer maxima east of the Rockies and the winter or spring maxima west of them are found more or less commingled in the Plateau Province. Thus we here find a combination of the marine rainfall régime of the Pacific coast and the continental régime of the interior.

Two well-defined rainfall types may be distinguished, one in the north, the other in the south. The rainfall distribution over the Northern Plateau Province, which may be called the *North Plateau* type, is illustrated in

Figure 12. We have here a winter maximum (December-January), marine in character, and a mid- or late summer minimum (July-August), but there is a distinct increase in the rainfall towards the end of winter, reaching a secondary maximum in late spring (May). This is a continental feature, not found on the narrow Pacific coast. Some stations in this district have one maximum only, in spring, but July and August are the driest months at all the stations. The Missouri, or Eastern Rocky Mountain Foothills type, is sharply separated from the North Plateau type by the Rocky Mountain barrier. The seasonal variation of rainfall is by no means as marked as it is west

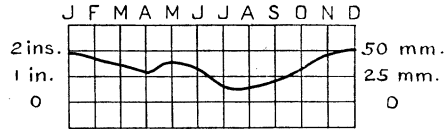


FIG. 12 -North Plateau type. Mean annual rainfall, 10-20 inches.

of the Sierra Nevada-Cascade barrier. These winter rains or snows of the North Plateau type are brought by the general cyclonic storms of the colder months, the moisture coming very largely from the Pacific Ocean. The spring and summer rains are mostly of thunderstorm origin. This North Plateau type of rainfall overlaps somewhat the southern boundary of our Northern Plateau climatic province, being found, as indicated on the map (Fig. 1), in northern Utah and in northern and northwestern Nevada. A few stations in the belt of country fringing the mountains in western Nevada share in the Pacific type of rainfall (see below), which here overlaps the Sierra Nevada from the west. The spring rains of Figure 12 are economically of much importance, either directly, because they fall when the crops are making their early growth, or indirectly, because applied through irrigation. As Messrs. L. J. Briggs and J. O. Belz have pointed out in an interesting report,⁶ spring wheat is not successful over much of this region because sowing cannot begin until late on account of the spring rains. Fall-sown wheat, on the other hand, has the benefit of the winter and spring rains and matures before the dry season of July and August. There is so little chance of rain during the "dry" months that grain is often left for days in the open air, piled in sacks, before being taken to storage. The winter snows on the mountains are economically important in maintaining the summer flow of the rivers, which otherwise, in the summer dry season of this province, would then have little or no water.

As we progress southward from the Northern Plateau Province into central and southern Nevada and Utah, a gradual change takes place in the rainfall type. In place of the late spring maximum of the North Plateau type, we find a more and more marked late summer (July-August) maximum, with a secondary maximum in winter. The primary minimum comes in spring and early summer (May-June), the secondary minimum in autumn (October-November). Figure 13 illustrates what we have named the *South*

⁶ L. J. Briggs and J. O. Belz: *Dry Farming in Relation to Rainfall and Evaporation*, *Bur. of Plant Industry Bull. No. 188*, U. S. Dept. of Agric., Washington, 1910, 71 pp.

Plateau type. This is a complex curve. It shares in the characteristics of the New Mexican on the east and of the characteristic rainfall distribution of the Pacific Slope on the west. It is on the whole most clearly developed in Arizona, but is found, often with more or less complication, over most of the Southern Plateau Province, including western Colorado and southeastern California. On the higher summits and slopes of the Colorado mountains

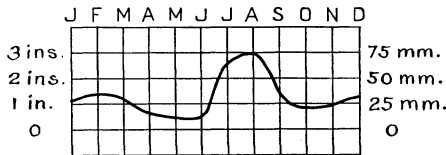


FIG. 13—South Plateau type. Mean annual rainfall, 10-15 inches.

most of the precipitation occurs in the colder months. States like Nevada and Utah, situated among three or four different rainfall types, naturally show considerable diversity and complexity in their rainfall types. In the South Plateau type, one-third or more of the annual rainfall comes in the months of July and August. The rainy season begins very suddenly, but there is a slow and moderate decrease towards the autumn minimum. The summer rains, which are very persistent, are afternoon or evening thundershowers of local convectional origin, occurring chiefly over the heated mountains and plateaus of this region, but also overlapping, to some extent, the adjacent valleys and plains. There is considerable variation in the annual amount of these rains. This fact suggests some more or less direct cyclonic control which is probably to be found in the permanent "Yuma low" over the lower Colorado. Water vapor from the Gulf of California is brought by the prevailing southerly winds on the eastern side of this low and is condensed as rainfall over the higher elevations. Weak secondary cyclonic depressions, moving eastward from the Yuma low, also seem to contribute a share of this summer rainfall. It is not improbable that the supply of water vapor from the Pacific Ocean is greater in summer than in winter, because the westerly winds are not likely to deposit as much moisture during their passage across the Sierra Nevada in the warmer season. The winter rains are cyclonic. They are more or less sporadic like the summer rains, occur in connection with low-pressure areas, are under the same general control as the winter rains of the Pacific coast, and depend for their intensity, amount, and distribution upon the character, development, and movement of the winter cyclones. The principal rainy season of the South Plateau type comes after the time of maturity of the staple crops, which are here dependent upon irrigation. The cold-season rains help winter pasturage, and the winter snows, where they fall, protect the grass. The snow which forms much of the winter precipitation on the higher mountains is important in maintaining a supply of water for irrigation in the interval before the late summer rains come.

RAINFALL TYPES OF THE PACIFIC PROVINCE

Our Pacific Province (i. e. the Pacific Slope west of the Cascade-Sierra Nevada divide) has well-marked winter rains, with wholly or nearly rain-

less summers. The rainy season usually extends from October or November to March or April. Over much of the area more than one-half of the annual rainfall comes in the period December-February. The rainiest month is generally December. At some southern stations it is February. The control of what has been termed the Pacific type of rainfall is to be found essentially in the equatorward migration of the cyclonic storm belt of the prevailing westerlies with the advance of autumn and winter and in the northward movement of this same storm belt in spring and summer. These are known as sub-tropical rains. They were first known and studied in the classic Mediterranean region of the Old World.

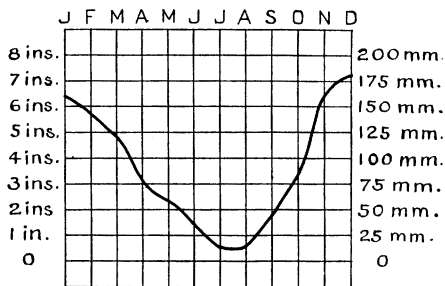


FIG. 14—North Pacific type. Mean annual rainfall, 40-50+ inches.

Later they were found, with similar characteristics, in Chile, on our Pacific coast, in southwestern Australia, in South Africa. In Washington and Oregon, and in northernmost California, the winter maximum is due to the fact that the land is then cold and that the westerly winds and their storms are then most active. Light rains from weak cyclonic depressions keep the warmest months from being absolutely dry. Farther south, while local thunderstorms may occur on the mountains in summer, the lower slopes and valleys are practically, or altogether, rainless. Both lowlands and mountains are warm and do not cool the winds as they do in winter. The length and intensity of the dry season increase from north to south. In the San Joaquin Valley, for example, three or four months may be rainless.

The essential difference in rainfall type between the northern and the southern sections of our Pacific Province is found in the character of the summer "dry" season, whose control is found in the northward withdrawal of the storm belt and its replacement by the northward extension of the margins of the trade-wind belt. For convenience, the state boundary between Oregon and California may be taken as the line roughly separating these two types of Pacific rainfall, although, as just pointed out, northernmost California is similar in its rainfall type to Oregon and Washington. To the north we have what we may call the *North Pacific* type (Fig. 14), with significant midsummer rains. To the south we have a *South Pacific* type (Fig. 15), extending over 500 or more miles along the coast, with wholly or practically rainless summers. This latter condition is of essential economic importance in making it possible to leave the harvested cereal crops outdoors, uncovered, during their removal to more permanent storage places, and in providing an unusually favorable opportunity for sun-drying fruits like raisins and apricots. On the other hand, the precipitation of the

colder months furnishes moisture for the fall-sown crops, which grow slowly through the winter months and are ready for harvesting at the end of the rainy season. The winter is the season when vegetation is green and fresh. In summer the landscape is brown and gray except where there is irrigation. The snowfall on the higher mountains provides the water necessary for irrigation when the winter rains are over. Afternoon thundershowers

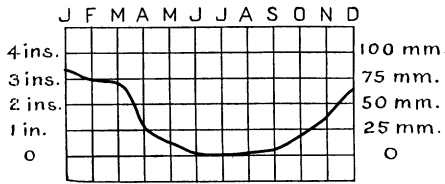


FIG. 15—South Pacific type. Mean annual rainfall, 10-15 inches.

and occasional light rains occur in some summers. In California, the rains of April and May are of the greatest value to agriculturists. No matter how abundant the winter precipitation may be, it is the rains of April and May which are the critical ones.

“RAINY SEASONS” IN THE UNITED STATES

It is clear from an examination of the foregoing curves that certain portions of the United States have distinct rainy seasons. Such rainfall types as the Missouri (Fig. 2), the Florida (Fig. 7), the New Mexican (Fig. 11), the Pacific (Fig. 14 and 15), in which there is a well-marked variation in the rainfall during the year, have rainy seasons. On the other hand, obviously, the Ohio (Fig. 3), the Tennessee (Fig. 6), and above all the New England (Fig. 4) types have so uniform a distribution of rainfall that to speak of rainy seasons is out of the question. These conditions of seasonal rainfall have been graphically presented by Professor Mark W. Harrington in a series of four charts of our “rainy seasons.”⁷ Districts which have equal percentages of their annual rainfall in their “rainy season” are enclosed by lines indicating that from 30 to 40, 50, or even 60 per cent of the annual amount comes in the two or three rainiest months. The area with over 30 per cent in the months of May, June, and July covers the northern and central portions of our Plains Province, reaches into the Upper Lakes region, and extends eastward as an elongated and narrowing zone as far as Pittsburg, Pa. (Missouri type). In the far Northwest, the percentage of rainfall in these three months is 50 per cent of the total. The 30 per cent line for July and August embraces eastern Arizona, practically all of New Mexico, and the western angle of Texas (New Mexican type). Most of this area has over 35 per cent in its rainy season. The 30 per cent line for July, August, and September reaches from Pensacola, Fla., to south of Cape Hatteras and includes Florida (Florida type). On the Pacific coast, with its marked winter maximum, December to February bring over 50 per cent of

⁷ Mark W. Harrington: Rainfall and Snow of the United States, Compiled to the End of 1891, With Annual, Seasonal, Monthly and Other Charts, *Weather Bur. Bull. C*, U. S. Dept. of Agric., Washington, 1894. Atlas and text. [Chart 20 and pp. 24-25 concern rainy seasons. The four charts in Bulletin C are combined in one in the Atlas of Meteorology, Pl. 19; text, p. 19.]

the annual rainfall in southwestern Oregon and over all of California except the extreme southeast (Pacific type). These charts show clearly the uniformity of precipitation throughout the year over most of the Eastern Province and the characteristic occurrence of summer rains east of the Rocky Mountains. West of longitude 114° W. over 30 per cent of the yearly rain falls in winter. Harrington has also shown the location of the maxima and the minima of rainfall by means of lines drawn centrally through areas where a maximum or a minimum occurs in any month.⁸ The most noteworthy features of these charts are the enormous area, east of the Rocky Mountains, with a June maximum; the extension of the winter maximum from the Pacific Slope inland and eastward generally as far as the continental divide; and the fact that the minimum rainfall area is more extended in winter than at any other season.

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Idem: The Distribution of the Rainfall in the Eastern United States, *ibid.*, pp. 14-24.

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[Note: In this series of papers the author presents charts showing the rainfall for each month by lines of equal departure from the rainfall norm, or "equipluves." The norm is the amount of rainfall that would occur at any place on the assumption that such rainfall was evenly distributed throughout the year. In other words, the usual *monthly* rainfall averages are expressed as percentages of the *annual* value at each station. This norm is shown by the equipluve of 100. Charts of the wettest and driest months and of rainfall regions are given, as well as diagrams of rainfall intensities.]

Idem: Rainfall and Agriculture in the United States, *ibid.*, pp. 267-274.

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[Note: The earlier work of Blodgett, and especially of Schott, contains much that is still of interest and of importance in connection with our rainfall types.]

⁸ *Loc. cit.*, Charts 19 and 21; text, pp. 23-25.